

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 May 2001 (17.05.2001)

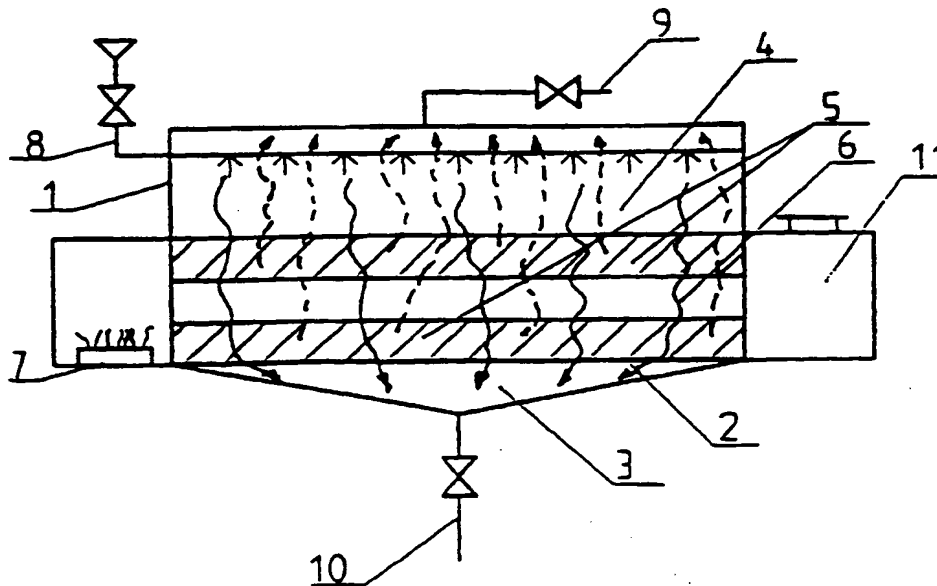
PCT

(10) International Publication Number
WO 01/34267 A1

- (51) International Patent Classification⁷: B01D 9/02, C02F 1/00 // 103:08
- (21) International Application Number: PCT/SE00/02183
- (22) International Filing Date: 8 November 2000 (08.11.2000)
- (25) Filing Language: Swedish
- (26) Publication Language: English
- (30) Priority Data: 9904083-4 11 November 1999 (11.11.1999) SE
- (71) Applicant (for all designated States except US): GOUGEL INDUSTRI AB [SE/SE]; Johan Skyttes väg 200, S-125 34 Älvsjö (SE).
- (72) Inventors; and
- (73) Inventors/Applicants (for US only): GOUGEL, Michail [SE/SE]; Bäckgårdsvägen 20, S-143 42 Värby (SE).
- (74) Agents: SUNDSTRÖM, Per et al.; Stenhagen Patentbyrå AB, P.O. Box 4630, S-116 91 Stockholm (SE).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published: — With international search report.

[Continued on next page]

(54) Title: A SYSTEM AND A DEVICE FOR DESALINATION OF WATER



(57) Abstract: There is used in a process and a device for desalinating saltwater a salt which will absorb water of crystallisation and which has a dissolution index of not higher than 10^{-24} . Saltwater is brought into contact with the salt, so that the salt will bind water from the saltwater and form a crystal hydrate. The salt freed from the saltwater is then heated, wherewith water is released as water vapour, which is collected and cooled to obtain desalinated water.

WO 01/34267 A1

WO 01/34267 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A SYSTEM AND A DEVICE FOR DESALINATION OF WATER**FIELD OF INVENTION**

5

The present invention relates to a process and to a device for the desalination of water, for use in domestic or industrial water desalination processes, for instance.

DESCRIPTION OF THE BACKGROUND ART

10

Saltwater desalination devices are known to industry, these devices generating distilled water obtained by boiling saltwater. These known devices comprise a closed vessel that includes heatable elements and are intended to receive salt water and to discharge vapour (steam) and salt concentrate. The saltwater desalinating devices known at present require a significant energy input, due to the fact that it is necessary to heat all of the saltwater present. Heat loss also increases in conjunction with this heating process as a result of salt-deposits on the pipes that deliver heat to the saltwater. Unless handled properly, the salt concentrate formed in the desalination process can deleteriously affect the environment when collected and later dumped.

20

SUMMARY OF THE INVENTION

The object of the present invention is to reduce energy consumption and to improve the use of the heat applied and, at the same time, to prevent dirtying of the ambient environment when taking care of rest products from the desalination process. In accordance with the invention, this object is achieved with a water desalinating process and a water desalinating device that differ from earlier known systems and devices by virtue of supplying saltwater to an hermetically-closed vessel that has been divided vertically into two parts by a perforated partition wall. A layer of salt that absorbs water of crystallisation has been placed in the upper part of the vessel over said perforated partition wall and in contact with heatable elements located in said upper part of the vessel. Means for collecting the salt concentrate have been disposed in the bottom part of the vessel, beneath said perforated partition wall. Pipes that function to supply saltwater and carry away water vapour, steam, have been connected to the upper part of the vessel above said salt layer. A pipe for

30

carrying away rest products, such as the saline concentrate, have been connected to the bottom part of the vessel. The salt that absorbs water of crystallisation is preferably one that has a dissolution index (dissolution capacity) of not higher than 10^{-24} , for instance $Mg_3(PO_4)_2 \cdot n \cdot H_2O$ ($n=12-22$). The upper part of the vessel is preferably coupled to a low pressure source. When saltwater is delivered to the vessel, the salt that absorbs water of crystallisation will absorb water and form a crystal hydrate. After stopping the supply of saltwater and heating the crystal hydrate, the hydrate will emit the absorbed water as water vapour, which can then be condensed to obtain distilled water. A new desalination process can be started, subsequent to this heating and water-emitting process.

10

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 illustrates schematically the construction of an inventive desalination device.

DESCRIPTION OF A WORKING EMBODIMENT

15 The inventive saltwater desalinating device is comprised of an hermetic vessel 1 provided with a perforated partition wall 2 that divides the vessel vertically into two parts, a bottom part 3 and a top part 4. Disposed in the top part 4 of the vessel above the perforated partition wall 2 are heatable elements 6 and a layer of salt 5 that will absorb water of crystallisation, said salt being in direct contact with the heatable elements 6, wherein said
20 elements are connected to an energy source 7 with the ability to ventilate away generated heat 11. Saltwater is delivered to the vessel 1 through a closeable pipe 8, and a closeable pipe 9 is provided for carrying away water vapour, said pipes being placed in the upper part 4 of the vessel, above the salt layer 5. A pipe 10 is provided for carrying away salt concentrate that has collected in the lower part 3 of the vessel as residues from the
25 absorption of water by the absorption salt 5.

The device operates in the following way: Saltwater to be desalinated is delivered to the pipe 8 connected to the upper part 4 of the vessel 1. The saltwater passes through the layer of salt 5 that absorbs the water of crystallisation, wherewith pure desalinated water is bound to the salt, which therewith forms a crystal hydrate. The remainder of the saltwater
30 delivered to the vessel, said water now having a higher salt concentration, is carried away

from the bottom part 3 of the vessel through the pipe 10. Heat is then applied to the layer of crystal hydrate 5 through the heatable element 6 from the heat source 7, wherewith heating of the layer 5 causes said layer to emit the water that the salt absorbing the water of crystallisation has earlier bound to itself to form a hydrate. Any surplus heat is ventilated out through the device 11. The water restored from the hydrate is emitted in vapour form through the pipe 9. Cooling of this vapour converts the vapour into distilled water. A further desalination process can be carried out upon completion of a preceding desalination process. Because the crystal hydrate need only be heated after having bound pure water from the saltwater and because remaining liquid can be carried away, less heat is required to obtain the same amount of distilled water than that required in the earlier known devices, in which it is necessary to heat all of the saltwater. The separated, collected and discharged salt concentrate need never be heated, said heating process being used solely to heat the formed crystal hydrate. Moreover, there is no time-related increase in heat losses, owing to the fact that no salt will coat the heatable elements and pipes. Trials have shown that a suitable salt that absorbs water of crystallisation is one that has a dissolution index of not higher than 10^{-24} , since otherwise the need to add new crystals becomes greater. $\text{Mg}_3(\text{PO}_4)_2 \cdot n \cdot \text{H}_2\text{O}$ ($n=12-22$) is an example of a suitable salt in the present context, although it will be understood that other salts capable of absorbing water of crystallisation can be used.

The provision of sensors in different parts of the device enable different operating conditions to be registered in a desalination process. The desalination process can be controlled, either manually or automatically, with the aid of a computing and monitoring system on the basis of the registered operating conditions. Electrical energy generated by solar cells can be used to heat the heatable elements, in addition to conventional energy sources, therewith enabling a small portable desalination device that includes solar cells to be used to produce pure water under simple conditions, such as when living in the open air in the countryside, for instance.

The saltwater flow is indicated with full arrows, while the vapour flow is indicated with broken arrows in the drawing.

Reference signs

1 Hermetic vessel

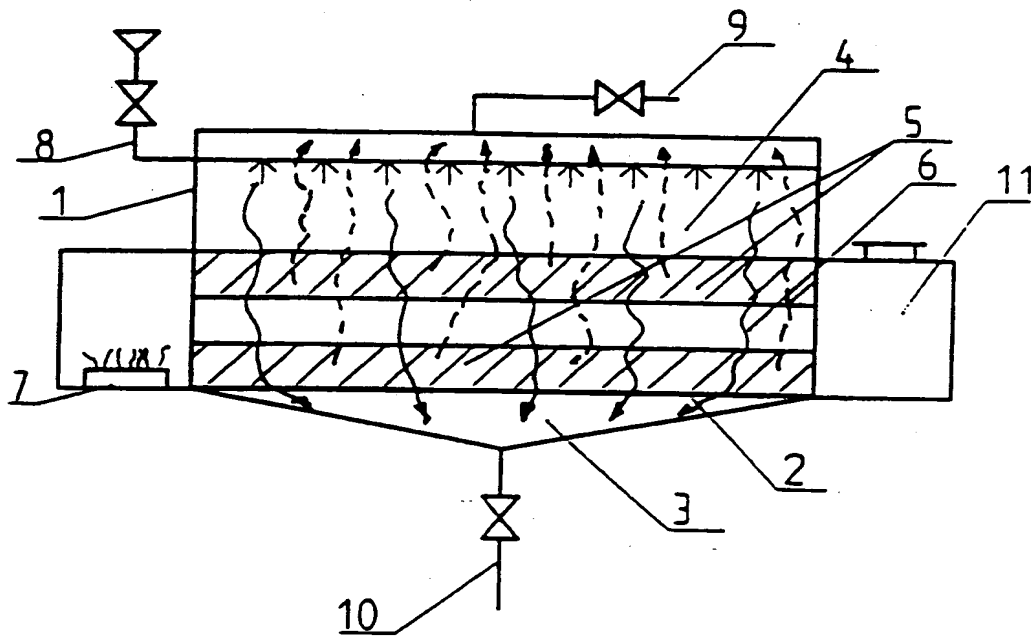
- 2 Perforated partition wall
- 3 Bottom part
- 4 Top part
- 5 Layer of crystals
- 5 6 Heatable elements
- 7 Heating source
- 8 Saltwater delivery pipe
- 9 Vapour discharge pipe
- 10 Liquid discharge pipe
- 10 11 Heat ventilation

CLAIMS

1. A process for the desalination of water in a vessel that includes heatable elements, characterised in that there is disposed in the vessel a layer of salt which will absorb water of crystallisation and which has a dissolution index of not higher than 10^{-24} and which binds water as water of crystallisation when coming into contact with saltwater, wherein remaining matter can be collected and discharged from the system; and in that subsequent to said salt that absorbs water of crystallisation having bound said water and formed a crystal hydrate, the water can be released by heating with the aid of said heatable elements, and wherein desalinated water is released as vapour which is collected and cooled to obtain desalinated water.
2. A process according to Claim 1, characterised in that the salt is $Mg_3(PO_4)_2 \cdot n \cdot H_2O$ ($n=12-22$).
3. A water desalinating device that includes an hermetically closeable vessel (1) that has heatable elements (6), a layer (5) of a substance that will absorb water of crystallisation disposed in an upper part (4) of the vessel, a perforated partition wall (2) disposed in the vessel beneath said salt layer (5), wherein the heatable elements (6), disposed in the layer (5) above the perforated partition wall (2) and connectable to an energy source (7), a closeable saltwater supply pipe (8) connectable to said vessel, a closeable vapour discharge pipe (9) connected to said vessel, and a closeable pipe (10) connected to the bottom part (3) of said vessel for the discharge of liquid, such as water enriched with said substance, wherein the substance that absorbs water of crystallisation is adapted to bind water to itself, said water being releasable by heating said substance, characterised in that said substance is a salt that has a dissolution index of not higher than 10^{-24} .
4. A device according to Claim 3, characterised in that the salt is $Mg_3(PO_4)_2 \cdot n \cdot H_2O$ ($n=12-22$).
5. A device according to Claim 3 or 4, characterised by a low pressure source that can be connected to the upper part (4) of the vessel.

1/1

FIG 1



1
INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02183

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 9/02, C02F 1/00 // C02F 103:08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01D, C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

QUESTEL: WPIL; STN: REG, CA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	File WPI, Derwent accession no. 76-66202X/35, ODESSA REFRIG IND RES: "Water desalination method - using crystal hydrate cycle", SU 487021, 19760223 --	1-5
A	File WPI, Derwent accession no. 81-357880/20, ODESSA REFRIG IND RES: "Desalination of water contg. salts by crystal hydrate formation with chlorine, sepn., melting and adiabatic expansion of gas", SU 755755, 19800815. -- -----	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

- | | |
|---|---|
| <p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> | <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p> |
|---|---|

Date of the actual completion of the international search 31 January 2001	Date of mailing of the international search report 27 -02- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Christensson/MP Telephone No. +46 8 782 25 00